

What is claimed is:

1. A method of manufacturing a potassium niobate ( $\text{KNbO}_3$ ) single crystal thin film, comprising the steps of:

- 5            maintaining the substrate under a predetermined oxygen partial pressure;  
             maintaining the substrate within a temperature region which is equal to or higher than an eutectic temperature of  $\text{KNbO}_3$  and  $3\text{K}_2\text{O}\cdot\text{Nb}_2\text{O}_5$  and is equal to or lower than complete melting temperature of  $\text{KNbO}_3$  and  $3\text{K}_2\text{O}\cdot\text{Nb}_2\text{O}_5$  so that a solid phase of  $\text{KNbO}_3$  and a liquid phase can coexist on the substrate;
- 10           depositing a vapor phase material on the substrate in a state in which a solid phase and a liquid phase coexist; and  
             precipitating  $\text{KNbO}_3$  on the substrate from the liquid phase as a solid phase to grow a  $\text{KNbO}_3$  single crystal thin film.

15    2. A method of manufacturing a potassium niobate single crystal thin film according to claim 1, wherein the composition of a starting material to be vaporized to generate the vapor phase material is from  $\text{K}_2\text{O}\cdot\text{Nb}_2\text{O}_5=50:50$  to  $\text{K}_2\text{O}\cdot\text{Nb}_2\text{O}_5=65:35$ .

3. A method of manufacturing a potassium niobate single crystal thin film according to  
20    claim 1, wherein the surface of the substrate has a structure in which crystal axes are oriented with respect to the surface in both the perpendicular and parallel directions, and  $\text{KNbO}_3$  precipitated from the liquid phase is grown into a single crystal using the substrate as the seed crystal.

4. A method of manufacturing a potassium niobate single crystal thin film according to claim 3, further comprising the step of physically or chemically removing the liquid phase which remains on the surface of the potassium niobate single crystal thin layer after the single crystal is grown.

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5. A method of manufacturing a potassium niobate single crystal thin film according to claim 3, further comprising the step of, before the  $\text{KNbO}_3$  is precipitated from the liquid phase, terminating the surface of the substrate with niobium atoms and potassium atoms by depositing niobium atoms and potassium atoms on the surface of the substrate at a

10 low deposition rate in order to improve the crystallinity of the potassium niobate single crystal thin film.

6. A method of manufacturing a potassium niobate single crystal thin film according to claim 3, wherein the substrate comprises a silicon single crystal substrate, a buffer layer grown epitaxially on the silicon single crystal substrate, and a potassium niobate single  
15 crystal thin film grown epitaxially on the buffer layer.

7. A method of manufacturing a potassium niobate single crystal thin film according to claim 6, the buffer layer comprises:

20 a first buffer layer consisting of a NaCl-type oxide that includes a metal that thermodynamically bonds more easily to oxygen than silicon; and

a second buffer layer consisting of a simple perovskite-type oxide deposited on the first buffer layer.

8. A method of manufacturing a potassium niobate single crystal thin film according to claim 6, wherein the buffer layer comprises:

a first buffer layer that consists of a fluorite-type oxide that includes a metal that thermodynamically bonds more easily to oxygen than silicon;

5 a second buffer consisting of a layered perovskite-type oxide that is deposited on the first buffer layer; and

a third buffer layer consisting of a simple perovskite-type oxide that is deposited on the second buffer layer.

10 9. A method of manufacturing a potassium niobate single crystal thin film according to claim 3, wherein the substrate comprises:

a base substrate that is a single crystal, a polycrystal, or amorphous;

a buffer layer that is grown on the base substrate at an in-plane orientation irrespective of the crystal orientation of the substrate by a vapor phase method involving

15 ion beam irradiation; and

a potassium niobate single crystal thin film that is grown epitaxially on the buffer layer.

10. A method of manufacturing a potassium niobate single crystal thin film according to

20 claim 9, wherein the buffer layer comprises:

a first buffer layer consisting of a NaCl-type oxide; and

a second buffer layer consisting of a simple perovskite-type oxide that is deposited on the first buffer layer.

11. A method of manufacturing a potassium niobate single crystal thin film according to claim 9, wherein the buffer layer comprises:

a first buffer layer consisting of a fluorite-type oxide;

a second buffer layer consisting of a layered perovskite-type oxide that is

5 deposited on the first buffer layer; and

a third buffer layer consisting of a simple perovskite-type oxide that is deposited on the second buffer.

12. A surface acoustic wave element comprising a potassium niobate single crystal thin  
10 film produced by the manufacturing method recited in claim 1.

13. A frequency filter comprising a surface acoustic wave element recited in claim 12.

14. A frequency oscillator comprising a surface acoustic wave element recited in claim  
15 12.

15. An electronic circuit comprising a frequency oscillator recited in claim 14.

16. An electronic device comprising a frequency filter recited in claim 13.  
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17. An electronic device comprising a frequency oscillator recited in claim 14.

18. An electronic device comprising an electronic circuit recited in claim 15.